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TECHNOLOGIES AND POSSIBILITIES FOR CO_2 CAPTURE & STORAGE

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Technologies and possibilities for CO_2 capture & storage

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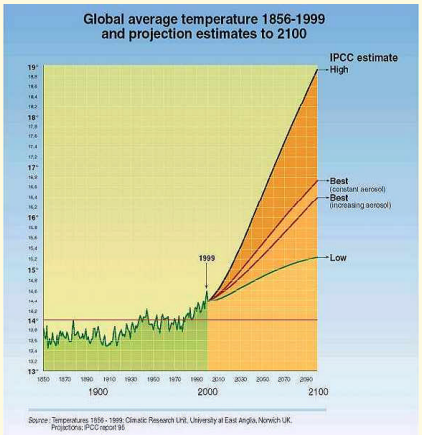
Technologies and possibilities for CCS

- **Background**
  - Need for deep reductions in greenhouse gas emissions
  - Portfolio of options for reducing emissions
- **Sources of CO_2**
- **Stages of the process**
  - Capture of CO_2
  - Transport of CO_2
  - Geological storage of CO_2
- **Performances and costs of CCS**

Background

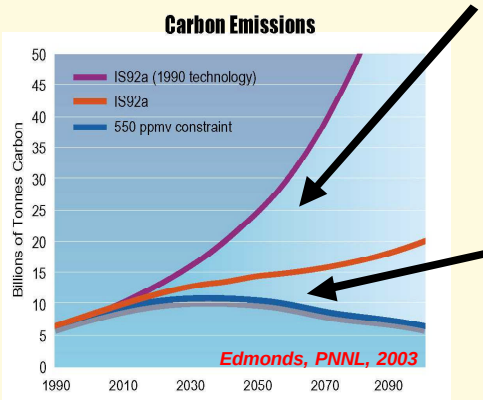
Our climate is changing!



Thus deep reductions in greenhouse gas emissions are needed!

Background

Portfolio of options to reduce emissions!



Assumed

significant advances In:

Fossil Fuels

Energy intensity

Nuclear

Renewable energy

Biotechnologies

Gap technologies

CO_2 capture & storage

Adv. Fossil fuel technologies

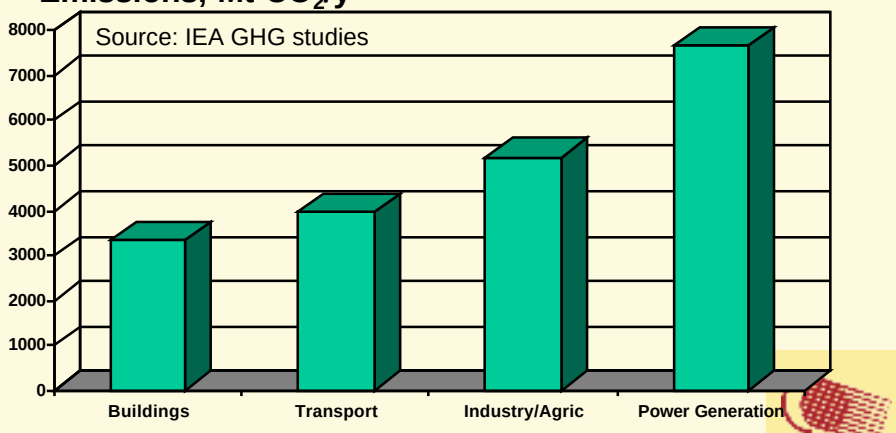
H_2 and Adv. Transportation

Biotechnologies

Sources of CO_2

Based on primary fuel at point of use

Emissions, Mt CO_2/y

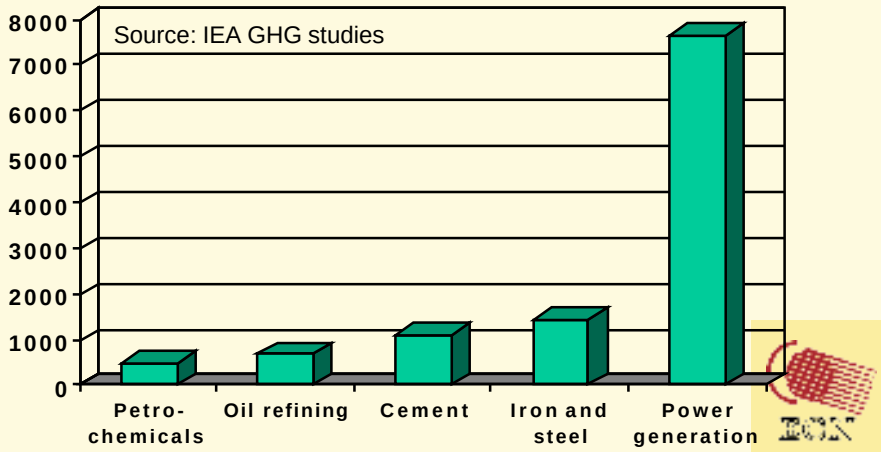


1997 data from IPCC TAR

Sources of CO_2

Industrial use

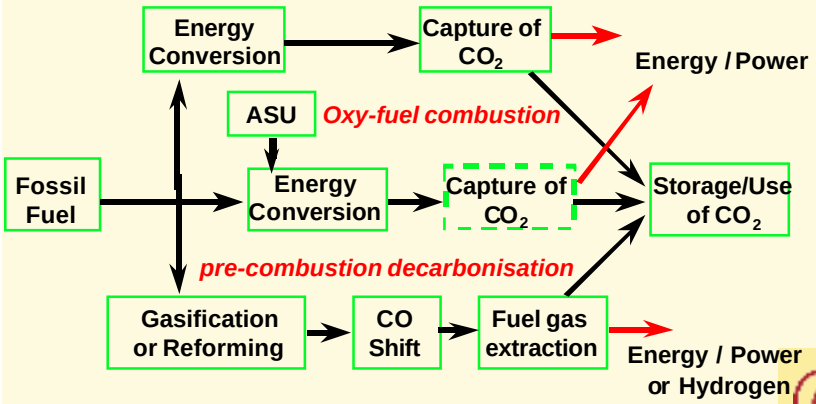
Emissions, Mt CO_2/y



Capture of CO_2

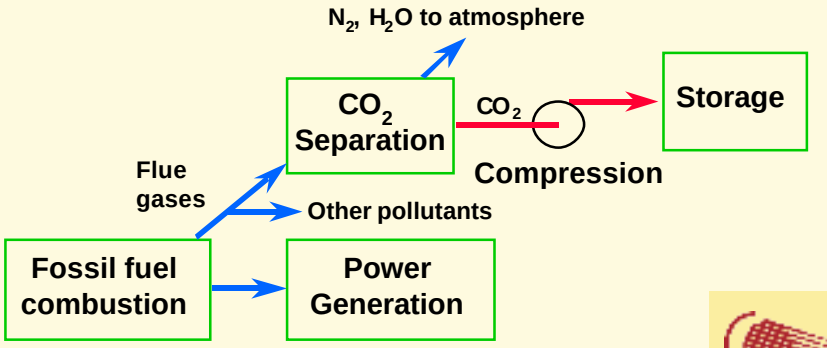
Three approaches

post-combustion capture



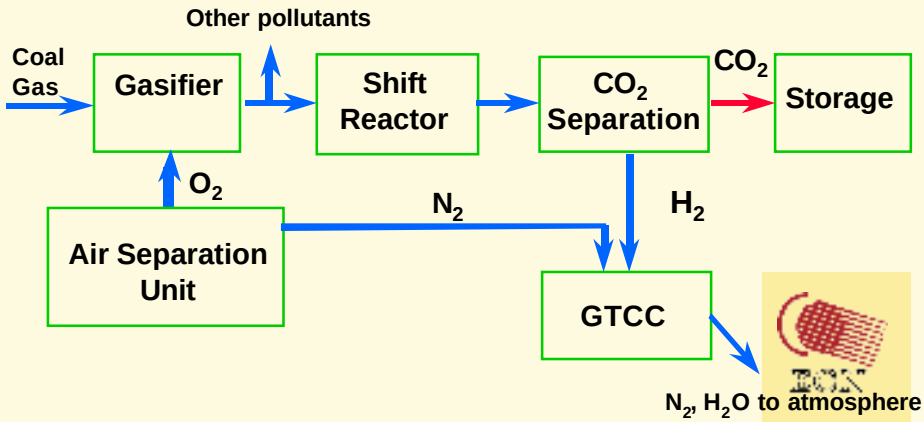
Post combustion Capture

Conventional power generation
Exiting technology



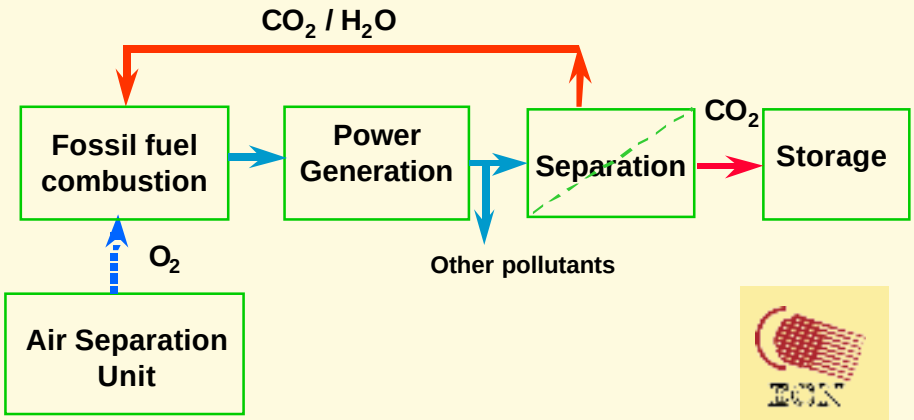
Pre-combustion Capture

Coal-fuelled power generation
IGCC with shift

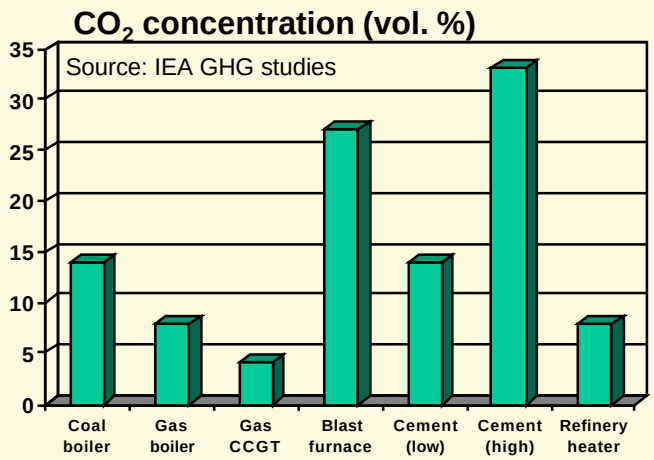


Oxy-fuel Capture

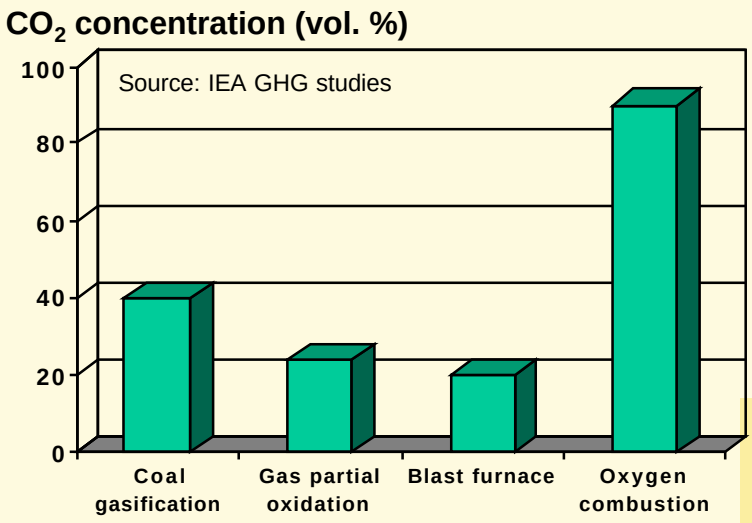
Power generation



CO_2 capture after combustion



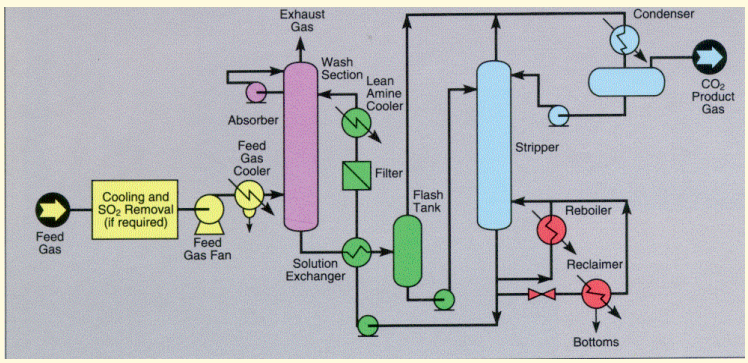
Capture before/during combustion



Current Status of Technologies

- **Post-combustion capture (amine scrubbing)**
  - Amine scrubbing well established for natural gas etc.
  - Some small power plants operating
  - Solvent degradation is a problem
- **Pre-combustion capture**
  - IGCC and ammonia production are established
  - Physical solvent separation well established
  - Gas turbines must be capable of using H_2-rich fuel
- **Oxygen-blown combustion**
  - Oxygen production is well established
  - Small scale combustor test rigs operating

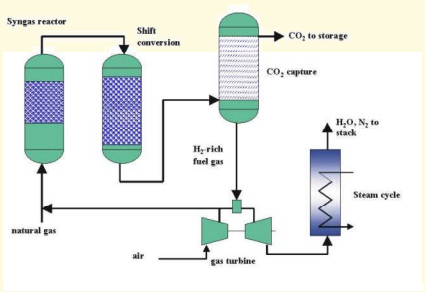
Post combustion CO_2 Capture



Capture efficiency 85%
Energy use per kg CO_2:
- 3-4 MJ_{th} low pressure steam
- 0.34 MJ_E voor compressie.

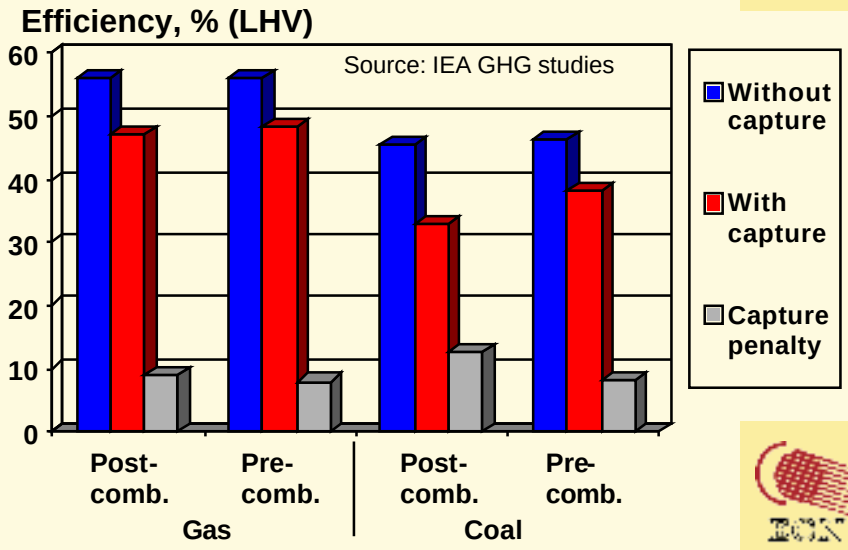
Pre-combustion CO_2 capture

- Fossil fuel to H_2/CO_2
- Separation of H_2/CO_2
- Integration with final conversion

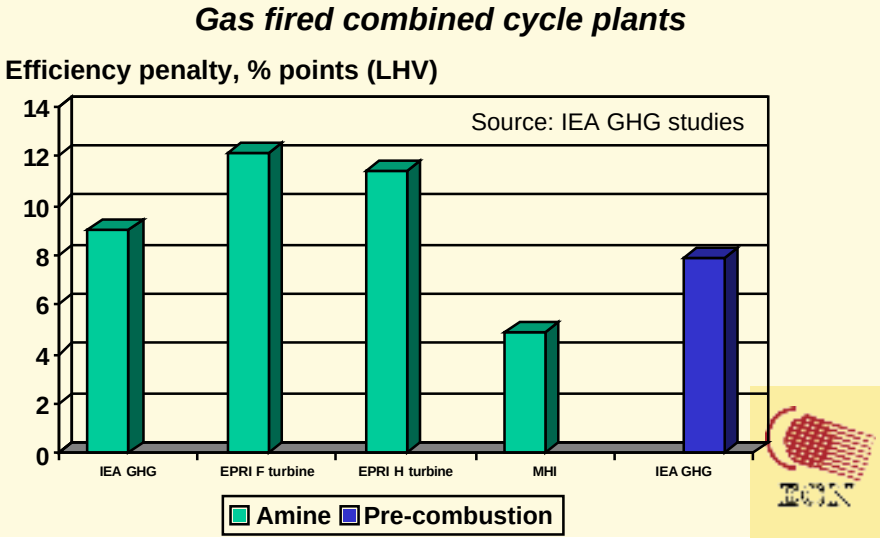


Capture efficiency > 85%
Energy use per kg CO_2:
- < 60% of post combustion
- 0.2 MJ_E voor compressie.

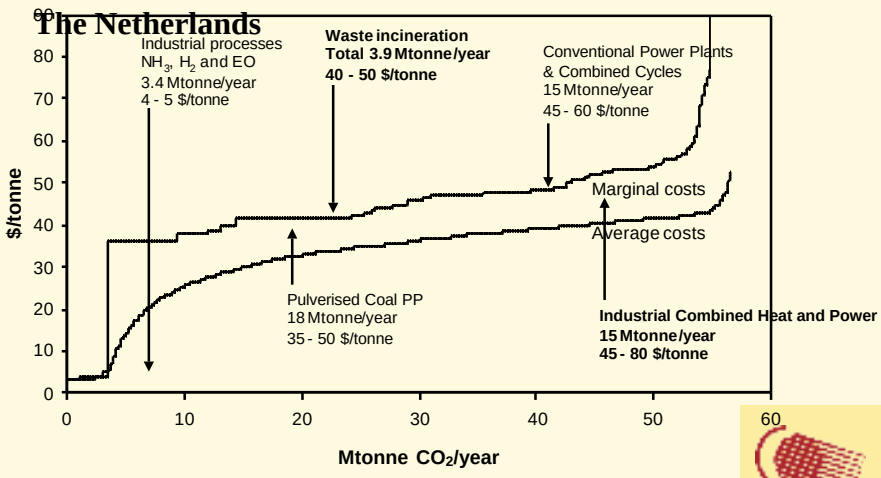
CO_2 Capture



CO_2 capture efficiency penalties



CO_2 capture costs



CO_2 transport: pipelines

Photo: Dakota Gasification

CO_2 pipeline:

3100 km in use today

Capacity > 110 Mt/y

Amount		300 km	
0.1	Mtonne/year	66	$/tonne
0.5	Mtonne/year	21	$/tonne
1	Mtonne/year	12	$/tonne
5	Mtonne/year	4.7	$/tonne

Source: Novem studie

CO_2 transport by ocean tanker

Hydro Agri CO_2-tankers, approximately 1500 m^3 capacity

- **CO_2 tanker:**
  - Long distance shipping could be done by tanker
  - Construction similar to LPG tanker
- **cost**
  - Similar to long distance pipeline

Geological storage of CO_2

Natural reservoirs that have storage capacity

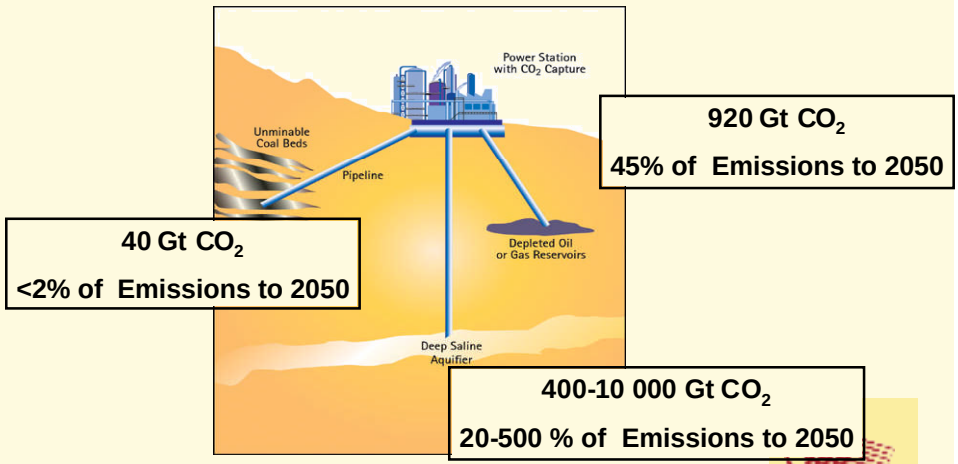
- Depleted oil and gas fields
- Deep saline reservoirs
- Unminable coal beds
- Deep ocean

Storage sites for CO_2 must be:

- Safe and secure
- Verifiable
- Of sufficient capacity

Potential for saleable products: EOR, ECBM

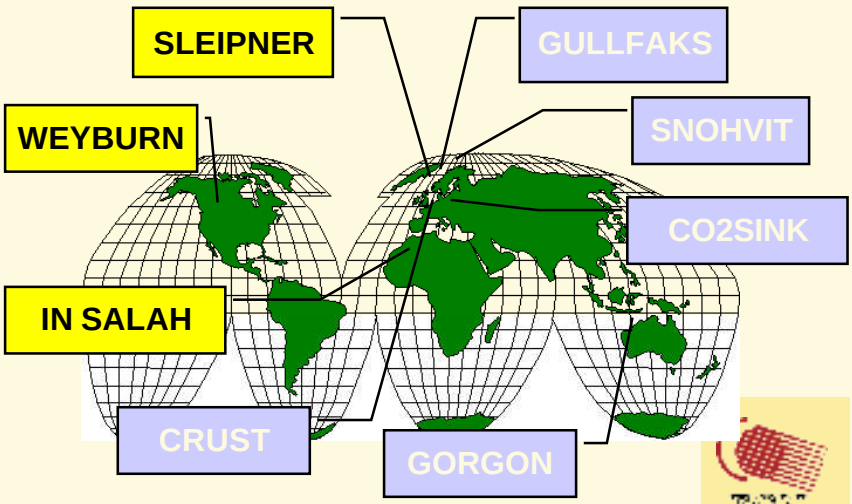
Global storage potential



Comparative potentials at storage costs of up to $20/t CO_2

Source: IEA GHG studies

Storage sites



Source: IEA GHG studies

SACS project STATOIL

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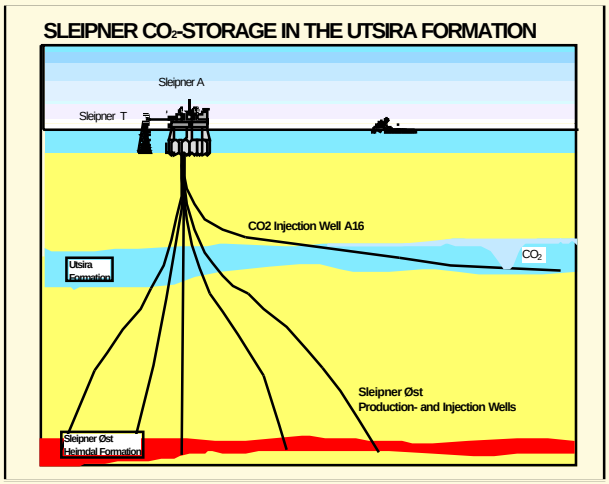
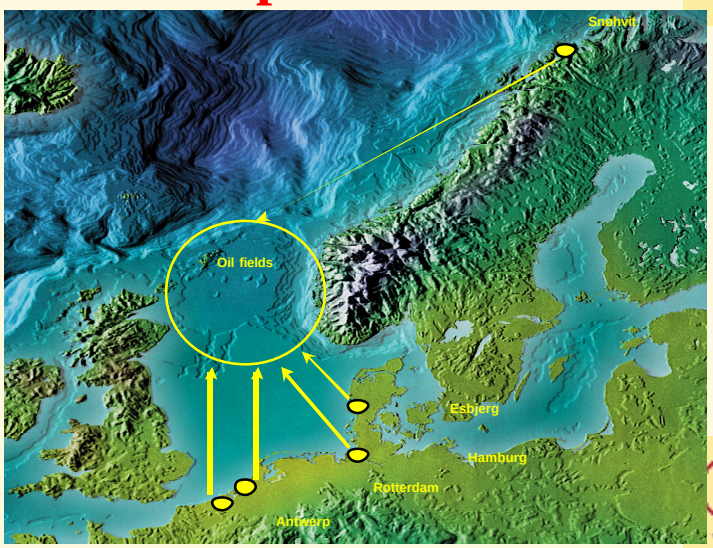
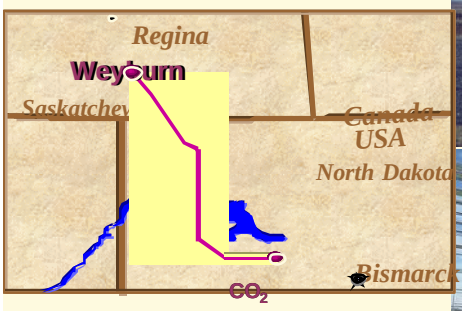


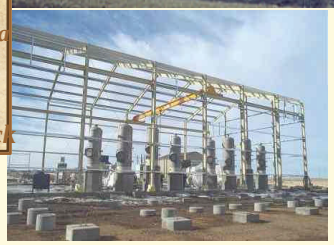
North Sea potential EOR sites



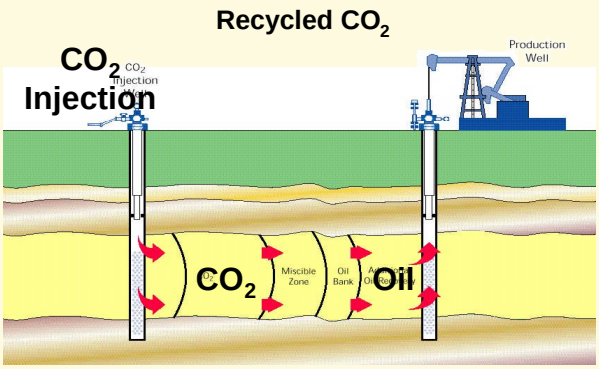
Oil fields (EOR)

Weyburn project in Canada uses CO_2 from USA





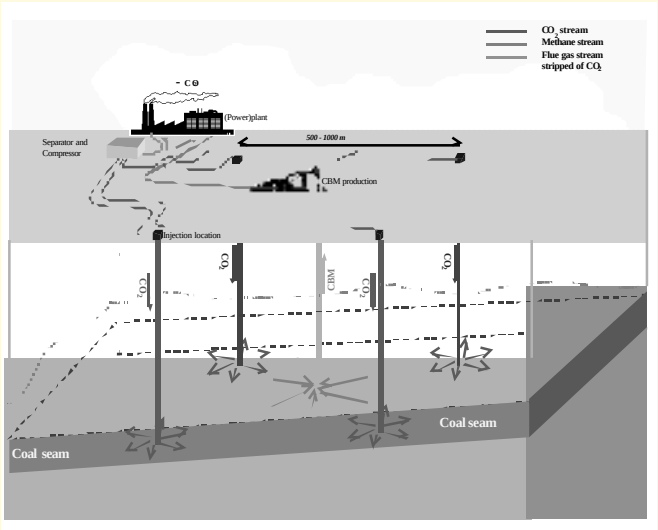
Oil fields Weyburn (EOR)



Additional oil production i.e. enhanced capacity

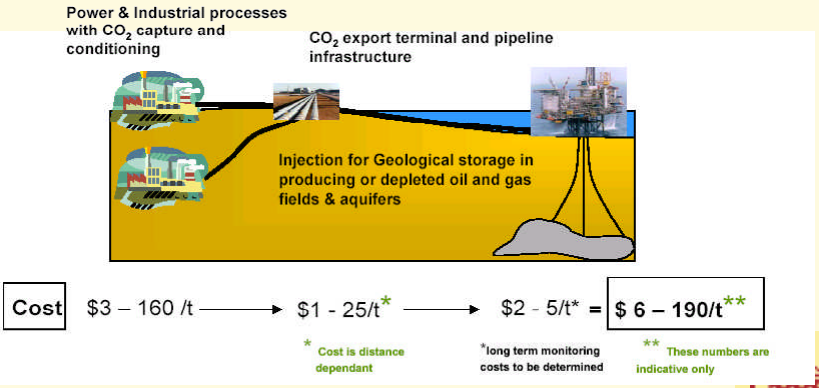
Applications today in USA and Canada (Weyburn)

Coal bed storage



CCS cost chain

CO_2 cost chain



Source CCP

Summary

Capture and storage of CO_2

- Can use existing technology to start
- Can deliver deep reductions in CO_2 emissions
- In large-scale application
  - Costs $20-50/t CO_2-avoided (total CCS chain power generation)
  - Competitive with other deep reduction options
- Enables continued use of energy infrastructure
- CO_2 capture and storage has an important role to as part of a portfolio of mitigation options

Acknowledgement

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